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4RF

4RF Application Note

Coexistence of fixed and space services at 2 GHz

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1 Introduction

Two narrow slices of spectrum at 2 GHz, used for a diverse range of space services applications, hold the key to our understanding of the universe and ultimately life itself. This same spectrum supports a range of perhaps less exciting but more far reaching activities that affect our daily lives in the form of long distance fixed wireless links that can connect rural and remote communities to the wider world.

Spectrum management involves a complex balancing act between frequency allocations and application coexistence to ensure maximum harmonisation can be achieved. For the 2 GHz band, this has resulted in two key conclusions. Firstly, there are clear spectrum allocations for mobile satellite and mobile cellular applications, including as fourth generation standards such as LTE are deployed. Secondly, there is a proven case for application coexistence between space services and fixed links, while also ruling against the possibility for coexistence between space services and mobile satellite or mobile cellular services.

This paper provides detail on:

- The diversity and importance of space services operating in the 2 GHz band
- The rationale for coexistence recommendations and why fixed links can coexist harmoniously with space services while mobile cellular services cannot
- The range of applications in the 2 GHz band and the spectrum allocations that have been agreed for maximum harmonisation

Aprisa XE point-to-point radio

2 Use of 2 GHz band by space services

Everyday life on Earth would not be possible without tools such as weather satellites, other space based observation systems, and the now ubiquitous communications satellites. Supporting these technologies are the manned space missions of many nations and the global space science community. Reaching beyond the Earth to our solar system, galaxy, and the universe itself, space craft and supporting research programmes are continuously expanding the boundaries of our knowledge.

At the 1992 World Administrative Radio Conference (WARC) meeting, the international allocations for space services in the 2025 - 2110 MHz and 2200 - 2290 MHz bands were elevated to primary status worldwide. This position has been confirmed and consolidated through subsequent meetings.

These bands are used for a huge variety of space services applications. Weather satellite programs of several nations, coordinated through the World Meteorological Organization, provide vital services to the public, from routine forecasts to warnings of severe storm events. In addition to weather these satellites track and monitor pollution, fires, even volcanic activity. Other Earth observations systems collect multi-spectral images for the understanding of agricultural, forestry, water resources, geology, coastal erosion, urban change, and other environmental issues.

The world's ability to cope with the threat of potentially catastrophic climate change will rely on the continued operation of these space systems.

ESA and NASA astronauts over New Zealand | Image: NASA

3 Coexistence options for 2 GHz space services band

Compatibility studies and other work carried out by WARC meetings and the ITU studied the technical and operating characteristics of mobile cellular systems and fixed links in the 2 GHz bands, to assess the likely emissions and interference such systems would cause to stations in the space science services, which are the primary application in the 2025 - 2110 MHz and 2200 - 2290 MHz bands.

These studies concluded that sharing between space services and high density mobile systems in these bands is not feasible, which meant that these bands could not be identified as possible IMT-2000 extension bands for current or future generations of cellular technology.

However, the studies concluded that fixed links, such as those using the Aprisa XE point-to-point radio, could harmoniously coexist with the space services, due to their low density, long distance linking characteristics.

There are a number of recommendations and footnotes adopted by the ITU with reference to these bands. Some of the most important are:

- Recommendation ITU-R SA.1154 determined and confirmed earlier study results that sharing between space services and high density mobile systems is not feasible and that the introduction of mobile systems may preclude the continued operation of space science services

- Recommendation ITU-R F.1247 addresses fixed service sharing with space science services and considers that these services have co-existed satisfactorily

- Footnote S5.391 was added to the allocation tables as a result of the 1997 WRC requiring administrations in making assignments to the mobile service in the 2025 - 2110 MHz and 2200 - 2290 MHz bands, not to introduce high-density mobile systems, as described in Recommendation ITU-R SA.1154, and shall take that Recommendation into account for the introduction of any other type of mobile system

- Recommendation ITU-R F.1098 and CEPT/ERC Recommendation T/R 13-01 establish practical channel arrangements for the fixed service in the 2025 - 2110 MHz and 2200 - 2290 MHz bands which should be specified for new 2 GHz fixed networks

4 Applications and spectrum harmonisation at 2 GHz

The frequency spectrum around 2 GHz is used to support a range of applications, including space services, mobile cellular services, mobile satellite and fixed links.

4.1 Space services

Despite the diversity of spectrum allocations throughout the world, there is unusual consistency in the availability of the 2025 - 2110 MHz and 2200 - 2290 MHz bands. The space service now has secure primary status in this band. These are the most important of all available bands for Earth observation, launch control, spacecraft navigation and positioning, image transmissions, and many more applications involving manned spacecraft near Earth as well as for unmanned deep space missions.

4.2 Mobile cellular services

The cellular service has itself been evolving. Following the success of third generation (3G) mobile cellular services new technology is being developed for a more efficient high speed fourth generation mobile broadband standard. LTE is the long term evolution towards a new high performance air interface which will operate in a wide variety of frequency bands. Although in the past, various proposals have been made for the use of the space services spectrum for cellular networks, this possibility has now been eliminated due to an inability of these two services to harmoniously coexist.

4.3 Mobile satellite services

Mobile satellite services typically occupy spectrum from 1980 - 2010 MHz and 2170 - 2200 MHz, rather than overlapping with the space services spectrum allocations.

4.4 Fixed links

Fixed services links, such as those using the Aprisa XE, have been allocated use of the 2025 - 2110 MHz and 2200 - 2290 MHz bands, alongside the space services application. Not only is sharing this band with the space services application highly practical, but space science agencies such as NASA recommend and support the use of these bands by the fixed service, due to the ability of the two applications to harmoniously coexist.

Space services application:

Ariane 5 CA launcher lifts from Europe's Spaceport at Kourou, in French Guiana. Image: ESA-CNES-Arianespace ©2009

Fixed links application:

Aprisa XE: a compact, powerful, medium capacity point-to-point linking solution. A wide range of customer configurable interface options are integrated within the radio platform for the transmission of Internet, voice, and data traffic between two fixed points with proven performance over distances of more than 200 km.

4.5 Spectrum harmonisation

For more than 100 years the ITU has coordinated the shared global use of the radio spectrum and promoted international cooperation in spectrum matters. Today the ITU, operating on the basis of consensus, continues to manage allocations and promote efficient spectrum frequency assignments to support telecommunications development while avoiding harmful interference between different countries and services by means of World Administrative Radio Conference (WARC) meetings.

One of the key spectrum allocations that has been under consideration recently is that of third and fourth generation mobile cellular technology. Frequency bands have now been agreed, and these avoid the 2 GHz space service allocations. The table below summarises the key spectrum allocations across the 2 GHz band, highlighting the bands that the fixed service links share with space services:

Sub band (MHz)	LTE E-UTRA band	Description
1900 - 1920	Band 33 TDD / top band 39 TDD	TDD Region 1 & 3 PCS extension Region 2 (TDD 1900)
1910 - 1930	Band 37 TDD	TDD Region 1 & 3, PCS centre Region 2
1920 - 1980	Band 1 uplink	3G UMTS uplink Region 1, 2 & 3 (IMT core)
1930 - 1990	Band 2 downlink / band 36 TDD	3G UMTS uplink Region 1, 2 & 3 (PCS / TDD 1900)
1980 - 2010	NOT USED	Mobile satellite phone services uplink (subject to WRC-11)
2010 - 2025	Band 34 TDD	3G UMTS TDD Region 1 & 2 (TDD 2000)
2025 - 2110	NOT USED	Space services operations and earth exploration Fixed service links (ITU-R F.1098 & T/R 13-01 E Annex C)
2110 - 2155	Band 4 downlink	3G UMTS downlink Region 1, 2 & 3 (AWS USA downlink)
2110 - 2170	Band 1 down / band 10 down	3G UMTS downlink Region 1, 2 & 3 (IMT core)
2170 - 2200	NOT USED	Mobile satellite phone services downlink (subject to WRC-11)
2200 - 2290	NOT USED	Space services operations and earth exploration Fixed service links (ITU-R F.1098 & T/R 13-01 E Annex C)
2300 - 2400	Band 40 TDD	3G UMTS 2.3 TDD

From: ETSI TS 136 101 V9.1.0 'LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User equipment (UE) radio transmission and reception (3GPP TS 36.101 version 9.1.0 Release 9)', October 2009.

5 Conclusions

This paper highlights the importance of the space science services supported by many nations to the benefit of the entire planet.

The ITU and standards making bodies in conjunction with industry have finalised frequency allocations for cellular and its long term evolution, carefully preserving the 2025 - 2110 MHz and 2200 - 2290 MHz bands for the traditional sharing between space science and the fixed service.

The frequency plan developed in conjunction with the ITU, the 3rd Generation Partnership Project (3GPP), telecommunications standards bodies such as the European Telecommunications Standards Institute (ETSI), and industry now provides a roadmap for 3G and LTE cellular that avoids conflict with the space services at 2 GHz.

Fixed service microwave radio vendors like 4RF have a strong history of providing high performance long haul links in the 2 GHz bands and successful sharing with the space science services. These bands have a proven utility for implementing cost effective long distance telecommunications application, more vital than ever for economic development today.

Country embargoes are no longer required at 2 GHz now that the situation with respect to the cellular, space science, mobile satellite, and fixed services has been resolved allowing fixed service allocations to again be made in the lower 2 GHz spectrum.

6 References

- ITU Recommendation ITU-R SA.1154: Provisions to Protect the Space Research (SR), Space Operations (SO) and Earth-Exploration Satellite Services (EES) and to Facilitate Sharing with the Mobile Service in the 2025-2110 MHz and 2200-2290 MHz Bands
- ITU Recommendation ITU-R F.1247: Technical and operational characteristics of systems in the fixed service to facilitate sharing with the space research, space operation and Earth exploration-satellite services operating in the bands 2025-2110 MHz and 2200-2290 MHz
- ITU Recommendation ITU-R F.1098: Radio-frequency channel arrangements for fixed wireless systems in the 1900-2300 MHz band
- CEPT/ERC Recommendation T/R 13-01: Preferred channel arrangements for fixed services in the range 1-3 GHz

About 4RF

Operating in more than 130 countries, 4RF solutions are deployed by oil and gas companies, international aid organizations, public safety, military and security organizations, transport companies and utilities, broadcasters, enterprises and telecommunications operators. All 4RF products are optimized for performance in harsh climates and difficult terrain, and support legacy analogue, serial data, PDH and IP applications.

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